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# Scientific Return of a Dust Analyzer at Io

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# New Frontiers: Io Observer

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- ▶ Suggested payload in AO:
  - ▶ Narrow-angle imager
  - ▶ Thermal mapper
  - ▶ Ion/neutral mass spectrometer
  - ▶ Flux gate magnetometer
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# Overview

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- ▶ Why is Io interesting?
- ▶ Dust detector capabilities
- ▶ What science can we get from a dust detector at Io?



# Io: Background

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- ▶ Most geologically dynamic body in the Solar System
- ▶ Hosts the Solar System's largest active volcanoes
- ▶ Provides a potential laboratory for investigating early volcanic processes on terrestrial planets (e.g., flood basalts on Earth, Mars, Venus)



# Benefits of a Dust Detector at Io

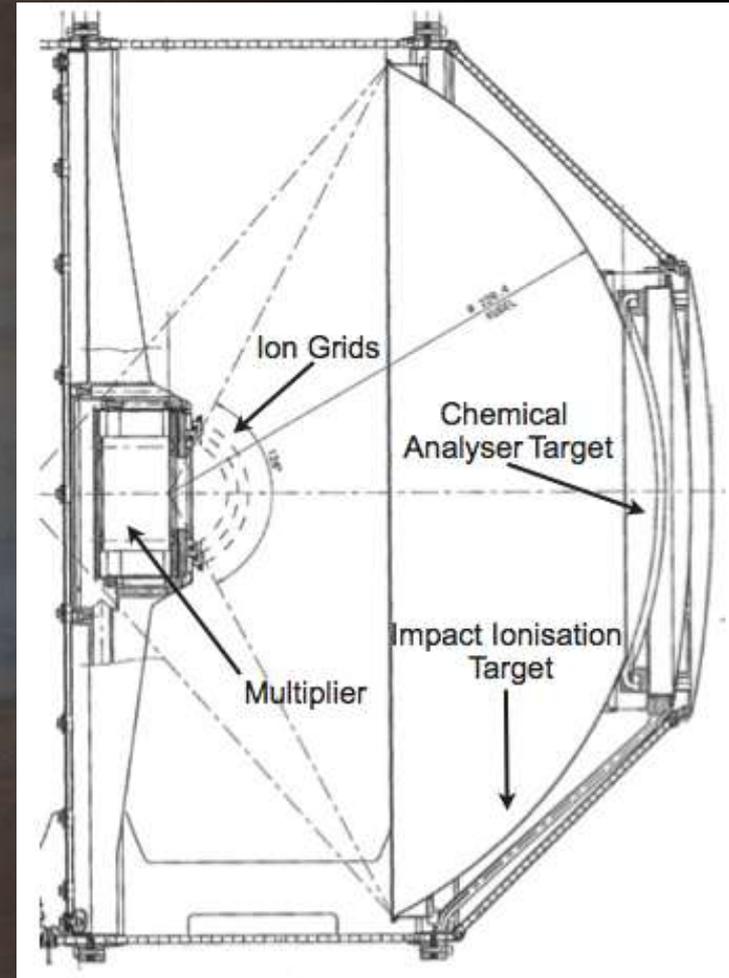
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- ▶ New science
- ▶ Provides powerful and unique way to determine surface composition
- ▶ Informs on the subsurface chemistry
- ▶ Monitor volcanic activity throughout orbit, even when Io is not in view



# Dust Detector—CALDERA

- **C**omprehensive **A**nalysis of **D**ust from **E**ructions and **A**tmosphere
- Impact-ionization dust analyzer with time-of-flight mass spectra capability
  - Heritage from Cassini Cosmic Dust Analyzer (CDA)
- Dual polarity functionality to measure positive and negative ion spectra
- Can measure dust composition and size distribution



# Iogenic Dust Sources

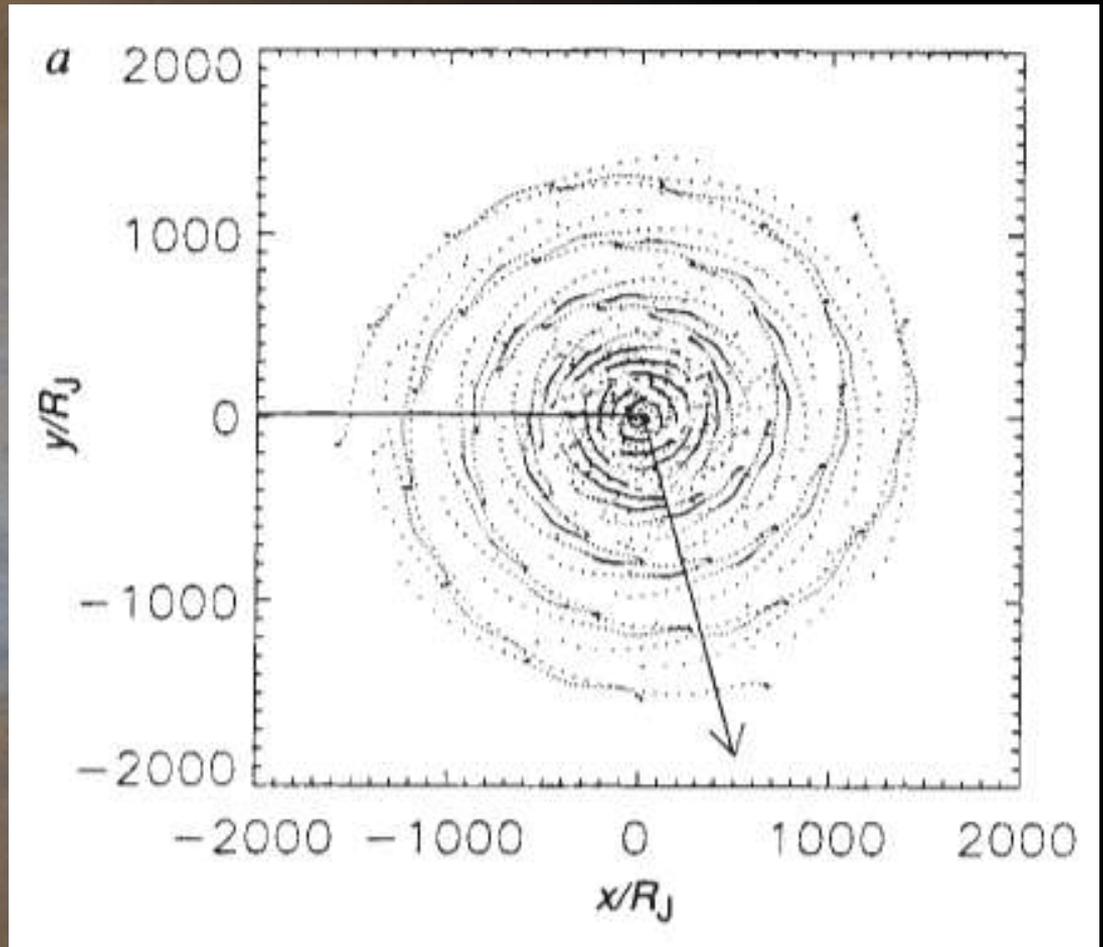
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- Volcanic eruptions observed by imagers aboard Voyager, Galileo, Hubble, Cassini, New Horizons
- Dust detected during flybys with the Galileo Dust Detector System (DDS) and Cassini Cosmic Dust Analyzer (CDA)
- Micrometeorite impacts



# Dust Migration Away from Io

- Co-rotational electric field of Jupiter leads to dust grains collecting charge and potentially spiraling away from Io



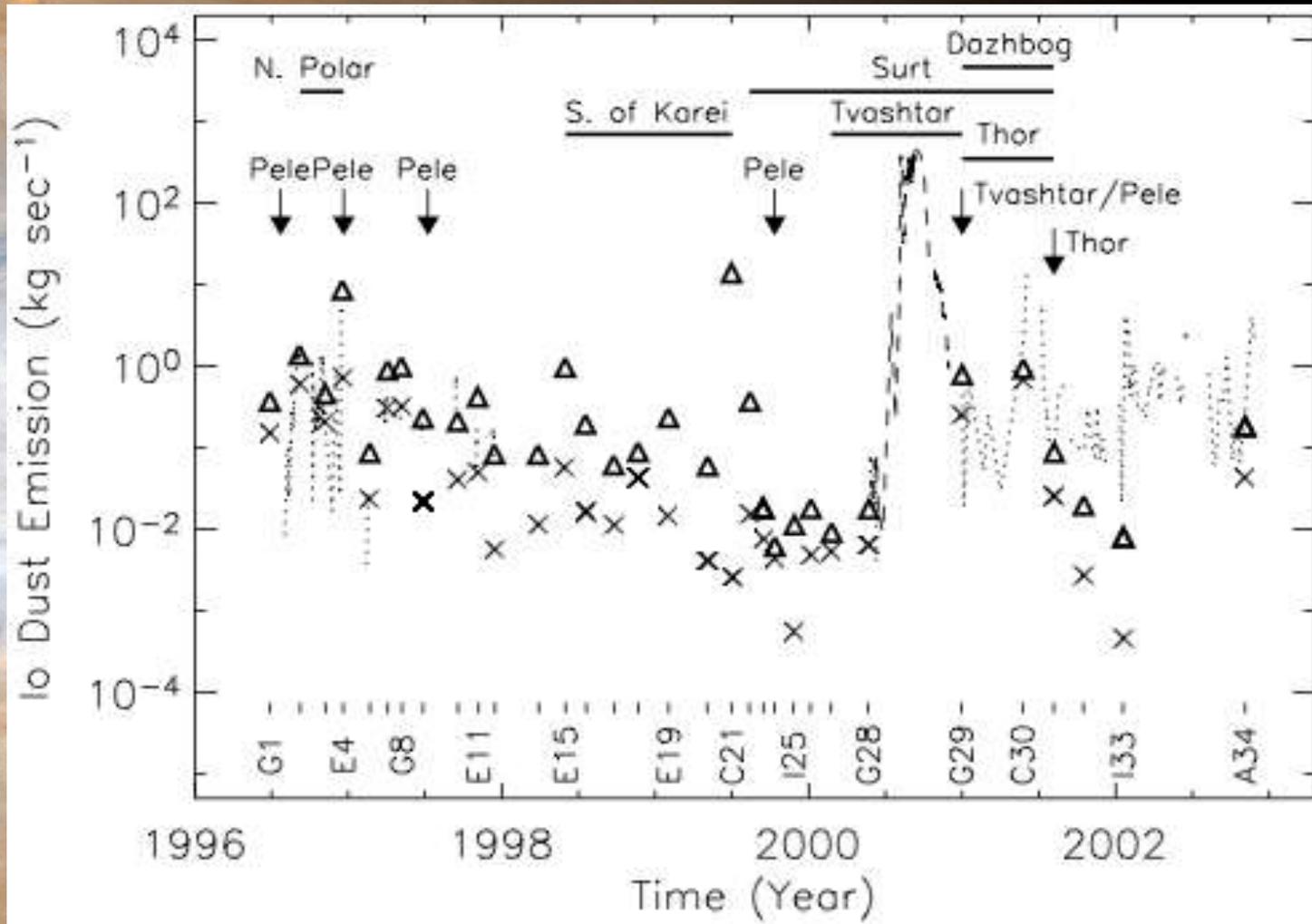
Horanyi 1993

# Dust Detector Science: Volcanism

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- Determine plume composition → is Io's volcanism sulphur- or silicate-based?
- Identification of silicates in plumes will provide information on the type and distribution of Ionian magma
  - Varying silicate content between plumes suggest different volcanic processes
  - Similar proportions may suggest a single dominant process, and potentially a central body of magma (e.g., “magma ocean” of Khurana et al. 2011)
- Monitor volcanic activity throughout the orbit, even when Io is not in view

# Dust Detector Science: Volcanism



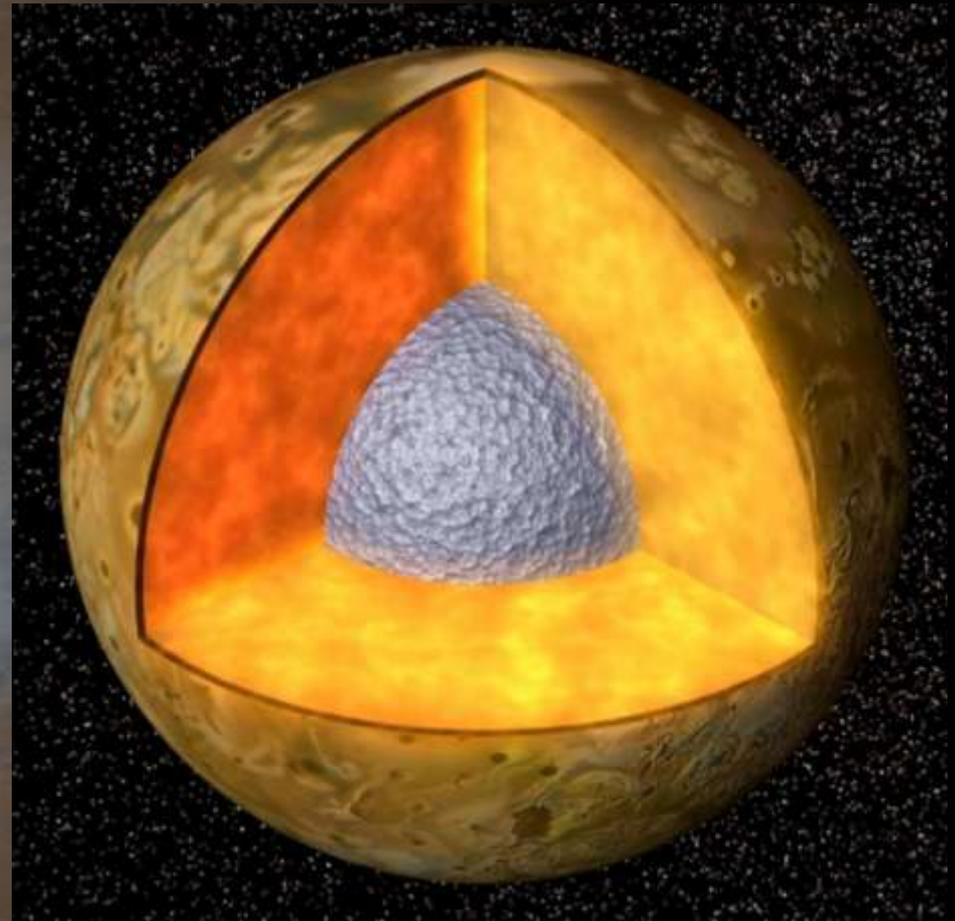
# Dust Detector Science: Surface & Atmosphere

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- Micrometeorite impact ejecta composition informs on surface composition
- Particle distribution measurements from plumes/impacts aid in determining Io's mass flux, atmospheric density profile, and loss of volatiles

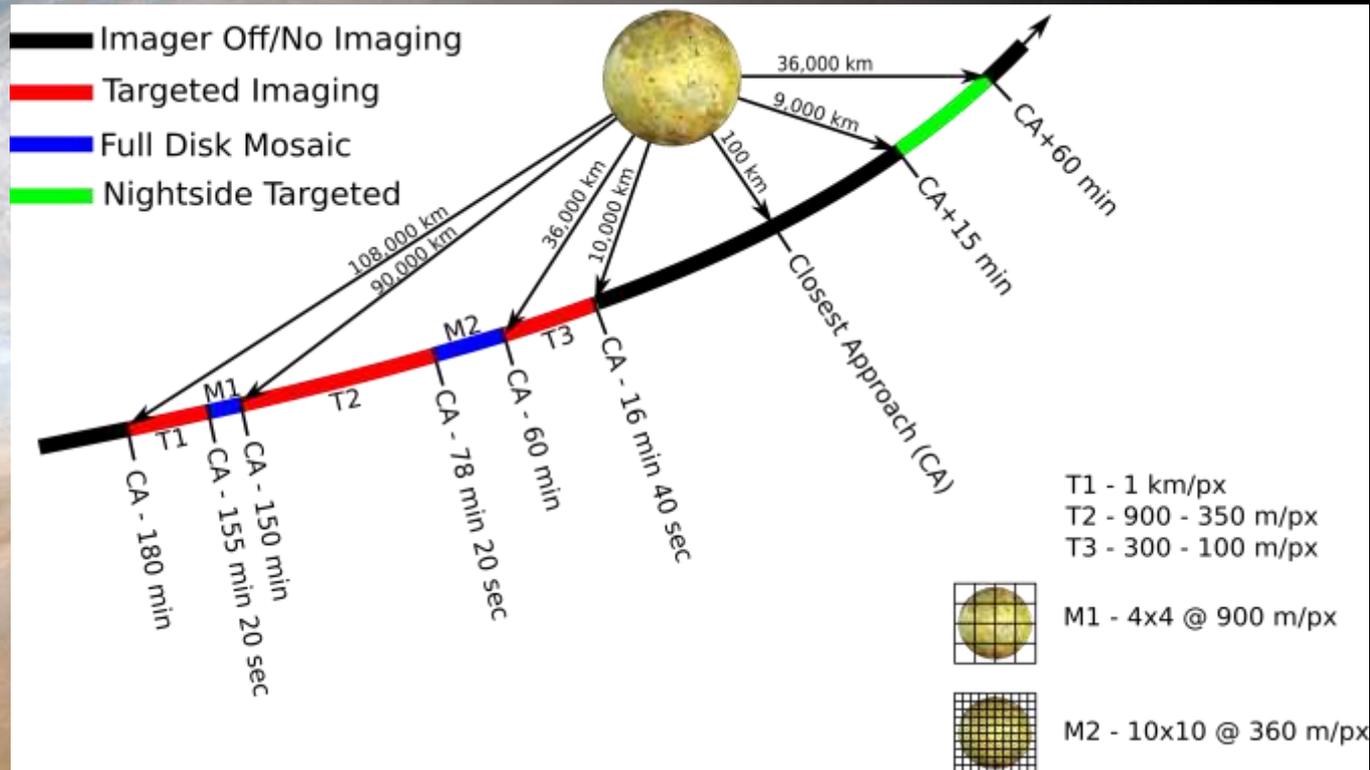
# Dust Detector Science: Interior

- Help constrain models of the degree of melting and differentiation of Io's interior by measuring composition of volcanic ejecta
- Isotope ratios (e.g.  $O^{16}/O^{18}$ ) can provide information on Io's formation and interior state



# Optimizing Science Return

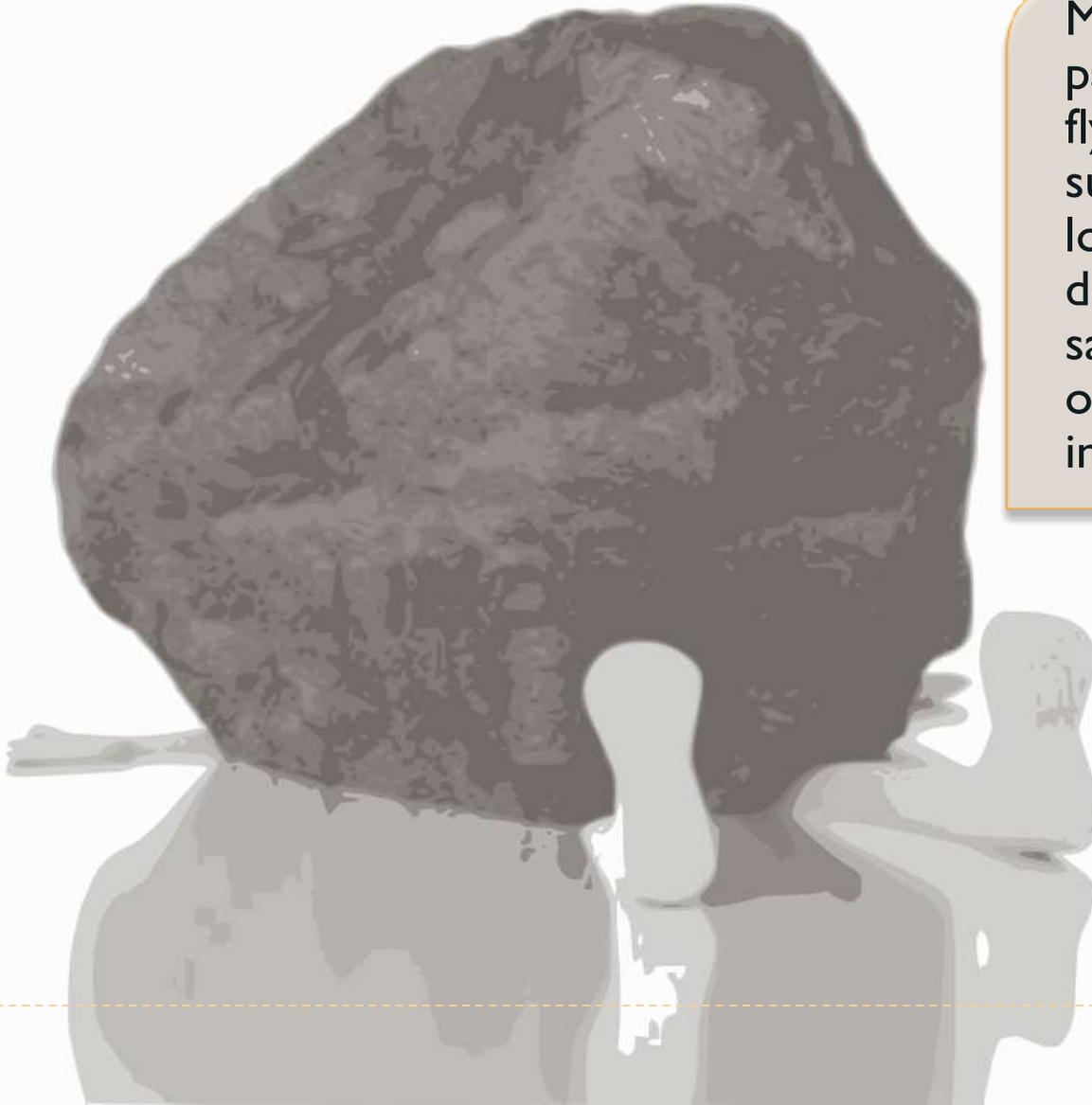
- Dust detector can collect useful data throughout a Jupiter-centric orbit, even when Io is not in view, whereas many other instruments would be limited to near-Io or line of sight observations



# Dust Detector Use: Risk Mitigation

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Monitor particle flux by flying by in successively lower orbits to determine safety of lower orbit to other instruments



# Conclusions

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- ▶ Including a dust detector on a future Io mission would provide invaluable information about Io's surface, interior, and atmosphere
  - ▶ Chemical composition of iogenic dust
  - ▶ Distribution of ejecta particles
  - ▶ Surface composition
  - ▶ Interior structure
  - ▶ Size distribution and chemical composition of dust in Io's orbital environment

